

FIG. 1

09/643,876 2/47 FEB 0 3 2003 Plant Name TRADEN Address City State General Zip Informa Phone tion Fax Contact User Size Industry # of pumps/mixers # of seals per pump # of sealed stuffing boxes in Plant % of pumps sealed % of pumps packed Average seal list price % of seals purchased new annually % of seals purchased as factory repair or rebuild kits Factory repair/rebuild price as a % of new seal price annually Plant % of population requiring solid shaft seals Profile Avg. shaft seal size (in inches) in plant # of Pumps, Mixers, Flushed With Seal Water into # of Pumps, Mixers, Stuffing Boxes which are flushed packed boxes with seal water which require evaporation later on. (Ex. Dilute black liquor pumps in pulp & paper Proposed Estimated Annual Seal Expenditure. industry. (Revised Plant Estimate New Seals Only) Average Seal List Price Per Seal Average Cost of 1 hour of Labor With All Benefits RECEIVED FEB 0 5 2003 Average Cost of Shaft or Sleeve Damage Included Avg. Cost for Bearings, Lip Seals, Gaskets, Etc. Additional Cost of Seasoned Trained Professional vs. **GROUP 3600** Cost Per Seal Per Year For Housecleaning (Please Novice Per Hour Annual Cost Of Production Dowtime Estimate) Actual/Estimated Plant Cost for One Failure Cost of Electricity Per Kilowatt Hours Average Cost Of Packing Set Informa Cost of Seal Flush Water Per 1,000 Gallons Evaporation Cost of 1 Gallon of Water

Cost of 1 million BTUs

tion

2A FIG.

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Ex. If Plant Seal Water Costs Are .15/1000 gallons and effluent treatment costs are .75/1000 gallons .75/.15 = 5	
Avg. Cost of Product/Gal. (Please keep in mind that fluids like condensate have a cost and should be included)	
Avg. Labor Cost of Unscheduled Repairs & Maintenance & Operations Combined)	
Production Cost of Machine Time Per Hour (Ex. Paper Machine)	
Cost of Housekeeping Service/Hours	
Split & Unsplit Average Price For Single W/Flow Meter or Double Seal Per Inch (Shaft Sleeve Dia.)	

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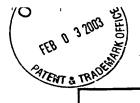
FIG. 3

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		sponsibility ide	in the field auto oment mfgs ho ct and all costs olete over time o suply these si will demand rea			Example: Seal Mfg assumes responsibility for performance	
	eck list	The supplier of product responsibility identifier	This section when completed in the field automatically feeds information back to equipment mfgs holding them esponsible for life of the product and all costs associated with it. This may become obsolete over time due to the fact that mfgs will not be able to suply these specificatins in the future as customers will demand real world solutions.	Seal Mfg. Specifications	What to Check Against	Manufacturers Specifications: Stuffing Box Face assumes Perpendicularit responsibility y - for Recommended performance	
	This is one example of one item on a check list	The suppli	This section when completed in the field automatically feeds information back to equipment mfgs holding them responsible for life of the product and all costs associated with it. This may become obsolete over time due to the fact that mfgs will not be able to suply these specificatins in the future as customers will demand real world solutions.	Pump Mfg. Specifications	What to Check What to Check Accountable Against Against Party Signoff	Manufacturers Specifications: Stuffing Box Face Perpendicularit y - Recommende d .007" TIR	
	example of		enables front line workers to identify ns in the field which drive all decisions ebuild and purchase of parts, etc. The klists act as the real world indicator to c precise life expectancy which up untilly obtained in labratory conditions.	st	When To Check	5 Performed in shop before equipment is disassemb led.	.020 - .030
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	Ĩ		enables front line workers to identify ns in the field which drive all decision ebuild and purchase of parts, etc. It klists act as the real world indicator it precise life expectancy which up us botained in labratory conditions.	ed Pictoria		Ö-L	.005
			t enables f ons in the rebuild an cklists act fic precise	Knowledge Based Pictorial/Checklist			.002 - .005
			This checklist enables front line workers to identify existing conditions in the field which drive all decisions regarding repair/rebuild and purchase of parts, etc. The equipment checklists act as the real world indicator to arrive at scientific precise life expectancy which up until now was only obtained in labratory conditions.	Knowl	Verification	Use a dial indicator to verify perpendicularity between the stuffing box face and the shaft O.D.	0002
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		4A	48			GROUP 3600	Actual
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			•	FIG	44		

FIG. 4A

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			Single Design	Double Design	Cartridge Design	Component Design	Stationary Design	Rotary Design	Balanced Design	Unbalanced Design	Tandem Design	Back to Back Design	Internally Mounted Design	Externally Mounted design	Large Clearance Design	Tight Clearance Designs	Dbl. seal with pumping ring design	Double seal without pumping ring design	
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FIG. 4B



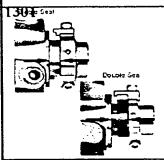
Seal Failure Analysis Inspection Form

To perform a seal failure analysis, you have been provided photos for all seal types typically found in service. Simply click on the photo(s) that best identifies the conditions of the seal you are analyzing.

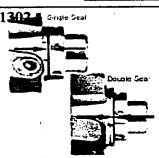
After all applicable pictures have been selected, click on the "When Failure Analysis Is Complete Click Here To Go To Seal Failure Analysis Report and Add Additional Comments/Notes If Required." button to continue.

If safety issues allow, inspect parts before and after cleaning as photos require.

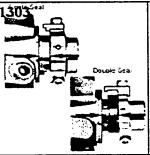
Cartridge Seal: Seal Settings



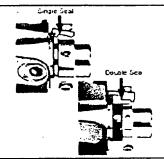
Incorrect settings due to seal being over compressed: Gap between lock collar and gland is too large. (Axial Direction)



Incorrect settings due to seal being under compressed: Gap between lock collar and gland is too small. (Axial Direction)

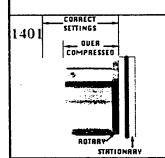


Incorrect settings due to gland face to shaft/sleeve not being perpendicular.

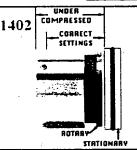


Incorrect settings due to shaft/sleeve being off centered to gland. Radial off-centering (up. down, left or right) between shaft/sleeve and gland ID

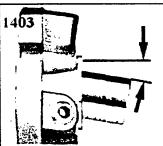
Component Seal: Seal Setting



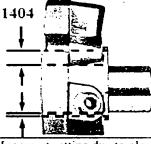
Incorrect setting due to seal being over compressed: Setting of rotary unit is wrong causing the scal to be over compressed.



Incorrect setting due to seal being under compressed: Setting of rotary unit is wrong causing the seal to be under compressed.



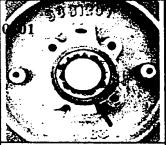
Incorrect setting due to gland face to shaft/sleeve not being not being centered to shaft. perpendicular.



Incorrect setting due to gland

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Cartridge Seal: Environment



Seal area packed with product



Seal gland packed with product



Carbon dust visible on front or ID of gland.



Crystalization/Solidification of product on atmospheric side of gland

FIG.





Seal area packed with product

to identify the most a probable 2 casue of failure

Reason

Cause

Verification

Corrective Action

Thermal sensitive fluids are not state in the seal area, causing it to build up on seal components

Cartridge: Seal chamber maintained in liquid temperature is raised or lowered beyond the solidification - point of the process fluid.

Cartridge: Verify the actual solidification point of the process fluid and the temperature maintained in the stuffing box seal area.

Cartridge: Review materials of construction recommendations. Review API plan and heating and cooling plan recommendations to control seal environment.

pack up in the seal area and on the seal components

Cartridge: Undissolved solids Heavy concentration are allowed to accumulate in the seal area.

Cartridge: of undissolved solids Verify concentration of the % of solids present in the process stream.

Cartridge: Review materials of construction recommendations. Review API plan and heating and cooling plan recommendations to control seal environment.

Undissolved fibrous solids pack up in the seal area on the seal components

Cartridge: Heavy concentration of fibrous solids are allowed to accumulate in the back cover/stuffing box.

Cartridge: Verify concentration of the % of solids present in the process stream.

Cartridge: Review materials of construction recommendations. Review API plan and heating and cooling plan recommendations to control seal en

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Thermal cycling resulting in premature seal failure.

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Inferior Casing Design For

Please confirm that an inferior casing design Temperature Control for temperature control is being used.

Replace GROUP 3600 casing design for temperature control.

Thermal sensitive fluids are not state in the seal area, causing it to build up on seal components

Component: Seal chamber maintain d in liquid temperature is raised or lowered beyond the solidification point of the process fluid.

Component: Verify the actual solidification point of the process fluid and the temperature maintained in the stuffing box seal area.

Component: Review materials of construction recommendations. Review API plan and heating and cooling plan recommendations to control seal environment.

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FIG. 6A

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FIG. 6B

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STORE OF THE STORE 316 SS Double A C1 & C2 require Double double seal Seal Type Single Operating Conditions Recommendations Seal Attributes T-9:9t:9 System Practice of reusing relapped soft seal fâces on cartridge and component seals. Practice of replacing soft seal faces on cartridge and component seals. wo Piece Carbon Soft Face Material Under Compression Practice of not using OEM certified faces in repair/rebuild One Piece Carbon Soft Face Material Under Compression Acetone; Tem <210 F Practice of using OEM certified faces in repair/rebuild wo Piece Carbon Soft Face Material Under Tension One Piece Carbon Soft Face Material Under Tension construc Compo Hastelloy C Metallurgy construc Compo Hastelloy C Metallurgy **7E 7F** Titanium Metallurgy itanium Metallurgy Alloy 20 Metallurgy Alloy 20 Metallurgy Material Cartridg 316SS Metallurgy Material Cartridg 316SS Metallurgy Seal Mfg/Model **2**C **Q**2 Seal Inf rmation 70 Z 78 e & nent nent Process Fluid s of tion s of tion FEB 0 5 2003 Sleeves Barrels Glands **GROUP 3600** 7 FIG. 7A

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	Rxn. Nickel Plate Cera Chrome Vito EP Tefl Afla Kalr Bond Bonde d TC mic Oxide n R on s ez SC d TC SC SC SC SC SC SC SC	Titan Carb Sintere Bond Bonde ATC mic Oxide n R on s ez z l The increase or	Titan Carb Sintere Bond Bonde of TC mic Oxide n R on s ez z l A A A A A A A A A A A A A A A A A A	Titan Carb Sintere Bond Bonde ATC mic Oxide I N A A A A A A A A A A A A A A A A A A	Titan Carb Sintere Bond Bonde Ium on d SC SC A T C III Alpha Bonde A T C III Chrome Oxide Ium on d SC SC A T C III Chrome Oxide Ium on d SC SC A T C III Chrome Oxide Ium on d SC SC A T C III Chrome Oxide Ium on B Ium on d SC II Chrome Oxide Ium on B Ium on B Ium on B Ium on II Chrome Oxide Ium on B Ium on B Ium on B Ium on II Chrome Oxide Ium on B Ium on B Ium on II Chrome Oxide Ium on B Ium on II Chrome Oxide Ium on B Ium on II Chrome Oxide Ium on Ium on Ium on II Chrome Oxide Ium on Ium on Ium on II Chrome Oxide Ium on I	Titan Carb Sintere Bond Bonde A TC mic Oxide n R N A A A A A A A A A A A A A A A A A A	Alloy Hast Titan Carb Sintere ed d TC mic Oxide n R n R n R n R n R n R n R n R n R n	Alloy Hast Titan Carb Sintere ed A Coride no la Scoride da TC mic Oxide no la Scoride da TC mic Oxide no la Scoride Alloy Hast Titan Carb Sintere ed	Alloy Hast Titan Carb Sintere ed d TC	Alloy Hast Titan Carb Sintere ed d TC mic Oxide	Alloy Hast Titan Carb Sintere ed a TC and Bonde Bonde a TC and Bon	Titan Carb Sintere ed d TC mic Oxide In Mark and d SC SC	Alloy Hast Titan Carb Sintere ed d TC mic Oxide n R in a bio is ez z i phoi se control d Sintere ed d TC mic Oxide n R in a bio is ex z z i phoi se control d Sintere ed d TC mic Oxide n R in a bio is ex z z i phoi se control d Sintere ed d TC mic Oxide n R in a bio is ex z z i phoi is ex z i phoi is ex z z i phoi is ex z i	A A A A A A A A A A A A A A A A A A A	Alloy Hast Trian Carb Alpha Bond Bonde Orde Cera Chrome Vito EP Teff Afla Kair Che Gra Bond Bonde Orde Orde Orde Orde Orde Orde Orde Or	Alloy Hast Trian Carb Appha Bond Bonde Date Cera Chrome Vito EP Teff Affa Kar Mickel Bonde Donde of TC mic Oxide n R A A A A A A A A A A A A A A A A A A	Alloy Hast Trian Carb Alpha Bond Bonde Plate Cera Chrome Vito EP Teff Alia Kair mra phoi Sintere ed d TC mic Oxide n R on s ez z l promise la Chrome Vito EP Teff Rair mra phoi Rair Rair Rair Rair Rair Rair Rair Rai	Alloy Hast Titan Carb Sintere ed d TC mic Oxide n R on s ez z l The increase or Sintere ed d TC mic Oxide n R on s ez z l The increase or Estimated Product life	Alloy Hast Titan Carb Aphra Ponde Ponde Donde Bonde Ponde Cara Chrome Vito EP Tell Afla Kalı Cha Grab Chrome Vito EP Tell Afla Kalı Chrome Vito EP	Alloy Hast Titan Carb Aphra Bond Bonde Plate Cera Chrome Vito EP Teff Afla Kair Che Gra Chrome Vito EP Teff Afla Kair Che Che Che Che Che Che Che Che Che Che	Alloy Hast Trian Carb Alpha Rxn. Nickel Bond Bonde Plate Cera Chrome Vito EP Teff Alla Kair mara phoi a SC SC d TC mic Oxide n R on s ez z l A A A A A A A A A A A A A A A A A A	Alloy Hast Trian Carb Sintered Bond Bonds Pate Cera Chrome Vito EP Teff And Karl mra phoi a SC G TC mic Oxide n R on s C Z I I The increase or Resource I I I I I I I I I I I I I I I I I I I	Alloy Hast Tran Carb Sintered Bond Bonds Plate Cera Chrome Vito EP Teff And Karl Chre Grad Chrome Vito EP Teff And Chre Grad Chrome Vito EP Teff And Chre Grad Chrome Vito EP Teff And Chre Chrome Vito EP Teff And Chre Chrome Vito EP Teff And Chre Chrome Vito EP Teff And Chre Chrome Vito EP Teff And Chre Chrome Vito EP Teff And Ch	Alloy Hast Trian Carb Sintere Bond Bonds Pate Cera Chrome Vito EP Teff And Kalf Chre Grad 20 C Ium on d SC SC d TC mic Oxide n R on s 2 z l life A A A A A A A A A A A A A A A A A A A	Alloy Hast Titan Carb Sintere Bond Brade Cera Chrome Vio EP Tefl Afla Kair Che Gra Che Che Gra Che Che Che Che Che Che Che Che Che Che	

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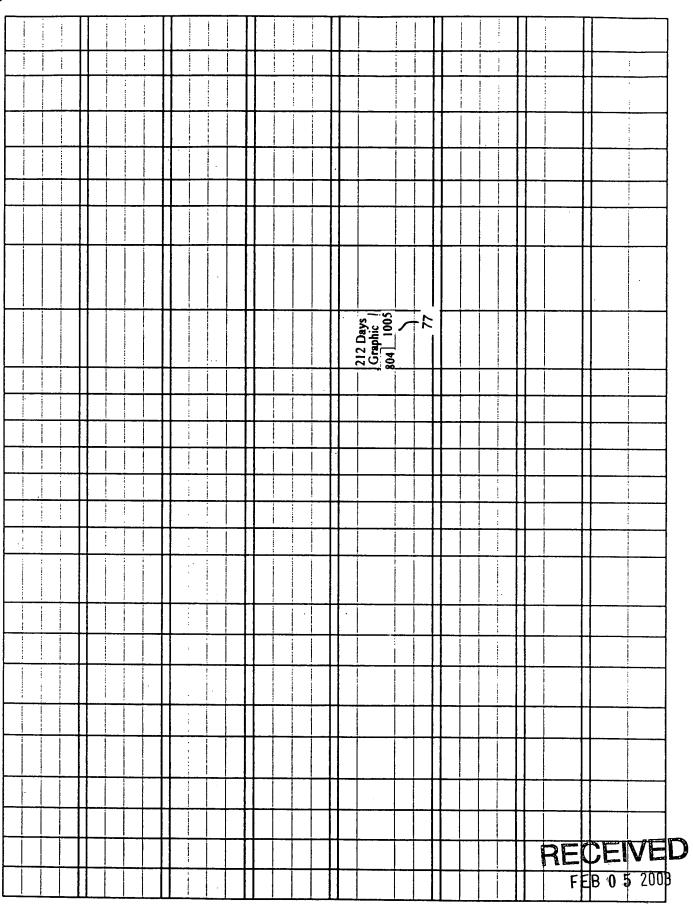


FIG. 7D

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is Viscos	is Viscosity > 15000	_									Product Has Viscosity
			15500							1	< 15000
· life inc	reases or decreases the H, M, O re	decre	sases the	H, M,	life increases or decreases the H, M, O resource costs as a result of all decisions when	a resul	t of all	decis	sions whe	٦	
E	Sing .	<u> </u>	Silling in	1030	.0.					\top	
t of M ources	Cost of Item	tem			Utilities		Safety		Environment al	Jent .	
Etc.	Cost of Item	о Ш .	Etc Energy/ Electirc	Wate	Wate Sewage	Etc .	Safet y	. Etc	Etc Safet Etc Environ y mental	Etc .	
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FIG							,				
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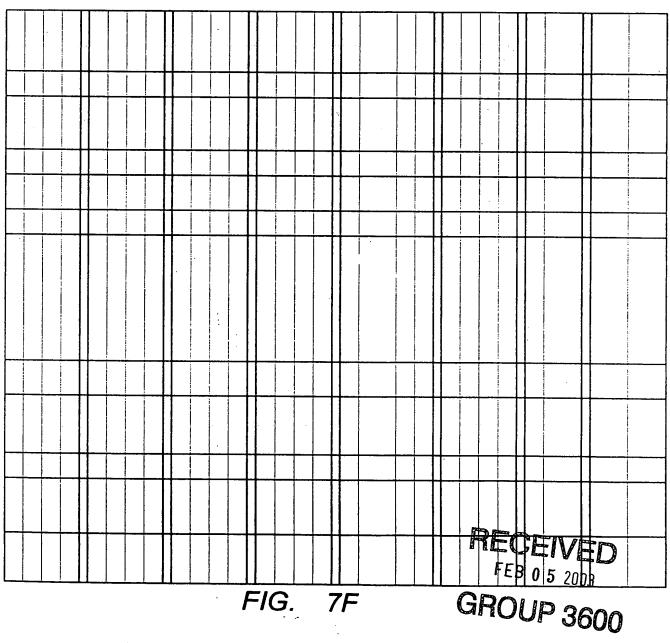


FIG. 7F

		18/47	
	Seal:	xxxxxxxxx	- 80
		Product/Service Skill Level Rating	~82
		Required	
	Specify	7.5	
	Purchase	5	
	Install with generic		
	installation	10	
	instructions		
	Install with		
	engineered	5	
	installation	. 5	
Seal	instructions		
Itself	Operate with generic		
	operating	5	
	instructions		
	Operate with	,	
	engineered	2.5	
	operating	2.5	
	instructions		
	Disposal	2.5	
	Sell	2.5	
Repair	Specify	2.5	
1	Purchase	2.5	
Rebuil	Repair	7.5	
d of	Disposal	5	
Seal	Sell	2.5	
	Specify	7.5	
	Purchase	2.5	ŀ
	Install with generic		
	installation	7.5	
	instructions		
	Install with		
	engineered	2.5	
API	installation	2.0	İ
Plans	instructions		
for	Operate with generic	·	
Seal	operating	5	
	instructions]
	Operate with		
	engineered	2.5	
	operating	2.5	
	instructions		
	Disposal	7.5	1
	Sell	2.5	

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FIG. 8

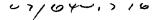


		3196 (Pump)
		Seal fits with no
	AV3000175A (Seal)	modifications
		Seal fits with no
	AV3200175EA (Seal)	
	AV3200173EA (Geal)	modifications
		Special gland
	XXXXX 5610	modifications required
		Special sleeve
	XXXXX Type 9	modificatins required
	XXXXX 155	
Seal	XXXXX 123	
	70000123	
		

These results come from the CA & SS from ESP

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		Process Fluid
	• •	Acetone; Tem <210 F
	,	System Recommendations
Recom		
mended		
Seal	·	Double
Туре	Davids	
	Double 246.68	^
Matalina	316 SS	A
	Alloy 20	
gy	Hast C	<u> </u>
	Titanium	· N
<u> </u>	Carbon	Α
	Alpha Sintered SC	A
	Rxn. Bonded SC	A
	Nickel Bonded TC	A
Faces	Plated TC	N
. 4355	Ceramic	A
	Chrome Oxide	N
	Viton	N
	EPR	A
Elastom	Teflon	Α
ers	Aflas	N
613	Kalrez	Α
	Chemraz	Α
	Graphoil	A
	C31- Mfg. Recommends The Use of A	
	Model that supports an option two piece	No
	stationary head	
	Pumping Feature Required	Yes
	Quench & Drain Required	No

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GROUP 3600

CENT 8 TO			: 1102, 1100										
ĺ			Analyze Constraints	Work Force Average Skill Leve	5								
			• •	Individual Skill Level John Mary	7 -								
			Gather Information To Make	Work Force Average Skill Leve									
		,	Purchasing Decision	Individual Skill Level John Mary	7 3								
			Assess Information	Work Force Average Skill Leve									
			,	loho	7								
			Individual Skill Level	Mary	3								
			Perform Analysis	Work Force Average Skill Leve									
				Individual Skill Level John	7								
				Mary	3								
			Decide on Repair/ Rebuild of	Work Force Average Skill Leve									
			product or service	Individual Skill Level John	7								
				Mary	3								
			Assess Safety Impact	Work Force Average Skill Leve	5								
				Individual Skill Level	7								
			Decide Sefety Begginsments	Mary	3								
	,		Decide Safety Requirements	Work Force Average Skill Level	7								
				Individual Skill Level Mary	3								
		Specify	Assess Environmental Impact	Work Force Average Skill Leve									
			, tosess Environmental Impact	lohn	7								
				Individual Skill Level Mary									
The same of the sa	ham kend		Decide Environmental	Work Force Average Skill Leve	1 5								
RECE	AEM		Requirements	Individual Skill Level John	7								
FEB 0 5	2003			Mary	3								
			Assess QC Requirements	Work Force Average Skill Leve									
GROUF	360)		Individual Skill Level John	7								
	·			Mary	3								
			Decide QC Requirements	Work Force Average Skill Leve	_								
	Skill Level Availab le	Skill	Skill								<u>.</u>	Individual Skill Level John Mary	7
•					Assess Mfgs. Capabilities	Work Force Average Skill Leve							
		.	, was a sum gen a ap a a muse	lohn	7								
			·	Individual Skill Level Mary	3								
			Decide on Mfg.	Work Force Average Skill Leve									
		<u> </u>	U	John	7								
·				Individual Skill Level Mary	3								
			Decide on Specifications	Work Force Average Skill Leve	el 5								
		İ		Individual Skill Level John	7								
				Mary	3								
		FIG. 11A	Decide and Prepare RFQ	Work Force Average Skill Lev	$\overline{}$								
				Individual Skill Level Bill	10								
	riG.			Passing PFO P	Ed	4							
	ŀ		ha Receive RFQ Responses and	Work Force Average Skill Lev									
			1 1/2	Analyze	Individual Skill Level Bill	10							
	l l	I		Ed	4								

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	Make Decision To Buy Product	Work Force Average Ski	II Level	7
		Individual Skill Level	Bill	10
		Individual Skill Level	Ed	4
	Assess equipment condition	Work Force Average Ski	II Level	6
	;	Individual Skill Level	Jim	9
Install		Individual Skiii Level	Ray	3
Instan	Install Product	Work Force Average Ski	II Level	6
		Individual Skill Level	Jim	9
		Individual Okili Ecvel	Ray	3
	Startup of Equipment	Work Force Average Ski	II Level	8
		Individual Skill Level	Mike	10
Operati		individud, Okim Edver	Jeff	6
on	Operation of Equipment	Work Force Average Ski	II Level	8
		Individual Skill Level	Mike	10
	<u>:</u>	marvidaa. Okiii Eever	Jeff	6
Dispos	Disposal of Equipment	Work Force Average Ski	II Level	4
al		Individual Skill Level	Wayne	6
		marviddar Okin Eever	Terry	2
	Decide on Sale	Work Force Average Ski	ill Level	4
Sell	:	Individual Skill Level	Sue	3
		Individual Skill Level	Lori	5

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23/47 T-9:9t:9 Seal **Attributes** Single Single Design Double Design Cartridge Design Cartridge Component Design Stationary Design Rotary Design Yes **Balanced Design** Yes Unbalanced Design Tandem Design Back to Back Design Internally Mounted Design Cartrid Gener **Externally Mounted design** Yes ge & al Comp Large Clearance Design Design onent **Tight Clearance Designs** Yes 1200 Double seal with pumping ring design Yes Double seal without pumping ring design High Balance Ratio Low Balance Ratio Yes Spring Loaded Design Metal Bellows Design Light Spring Load Per Square Inch High Spring Load Per Square Inch FEB 0 5 2003 Wide Face Width Narrow Face Width Single Seal with Large Dual Tangential Flush Holes Cartrid ge & Yes Single Seal with Small Straight Drill Holes Or No Flush Holes Design Comp onent Double seal with two flush holes on same surface Double seal with two flush holes 180 degrees apart Cartrid 316SS Metallurgy Yes Materi 1204 ge & Alloy 20 Metallurgy als of constr Comp Hastelloy C Metallurgy onent Titanium Metallurgy uction Cartrid Practice of using OEM certified glands in repair/rebuild ge & Comp onent | Practice of not using OEM certified glands in repair/rebuild Practice of replacing glands on cartridge seals with pitted surfaces FIG. 12A

STENT & TRADE

, .		1		
			Practice of reusing glands on cartridge seals with pitted surfaces	
			Practice of replacing gland on cartridge seals with damaged (elongated) spring holes	
		Cadrid	Practice of reusing gland on cartridge seals with damaged (elongated) spring holes	
Glands		ge	Practice of replacing cartridge seals with worn anti-rotation lugs,	
Ciands		·	pins, tabs, (tangs) in gland Practice of reusing cartridge seals with worn anti-rotation lugs, pins, tabs, (tangs) in gland	
	Repair &	, !	Practice of replacing cartridge seals with missing anti-rotation	
•	Rebuil ding		lugs, pins, tabs, (tangs) in gland Practice of reusing cartridge seals with missing anti-rotation lugs,	
	Proce dures		pins, tabs, (tangs) in gland	
	بر 1202		Practice of replacing glands on component seals with pitted surfaces	
	1202		Practice of reusing glands on component seals with pitted surfaces	
			Practice of replacing gland on component seals with damaged (elongated) spring holes	
		Comp	Practice of reusing gland on component seals with damaged (elongated) spring holes	
		onent	Practice of replacing component seals with worn anti-rotation lugs, pins, tabs, (tangs) in gland	
			Practice of reusing component seals with worn anti-rotation lugs, pins, tabs, (tangs) in gland	
			Practice of replacing component seals with missing anti-rotation lugs, pins, tabs, (tangs) in gland	
			Practice of reusing component seals with missing anti-rotation lugs, pins, tabs, (tangs) in gland	
	Materi	Cartrid	316SS Metallurgy RECFIVED	Yes
	als of constr	_	Alloy 20 Metallurgy FEB 0 5 2003	
	uction	onent	Titanium Metallurgy GROUD 2000	· · · · · · · · · · · · · · · · · · ·
			Practice of using OEM certified sleeves in repair/rebuild	
			Practice of not using OEM certified sleeves in repair/rebuild	
			Practice of replacing cartridge seals with worn drive lugs, pins, tabs, (tangs) in sleeve	
			Practice of reusing cartridge seals with worn drive lugs, pins, tabs, (tangs) in sleeve	
			Practice of replacing cartridge seals with missing drive lugs, pins, tabs, (tangs) in sleeve	
	:		Practice of reusing cartridge seals with missing drive lugs, pins, tabs, (tangs) in sleeve	
	ı	l i		

FIG. 12B

I			Practice of replacing sleeves on cartridge seals with damaged	
			(elongated) spring holes	
			Practice of reusing sleeves on cartridge seals with damaged	
			(elongated) spring holes	
			Practice of replacing cartridge seals with worn drive lugs, pins,	
		ge	tabs, (tangs) on rotary unit set screwed to sleeve	
			Practice of reusing cartridge seals with worn drive lugs, pins,	
			tabs, (tangs) on rotary unit set screwed to sleeve	
			Practice of replacing cartridge seals with missing drive lugs, pins,	
·			tabs, (tangs) on rotary unit set screwed to sleeve	
			Practice of reusing cartridge seals with missing drive lugs, pins,	
Sleeve			tabs, (tangs) on rotary unit set screwed to sleeve	
s or				
Barrel	Repair &		Practice of replacing sleeves on cartridge seals with pitted surfaces	
s	Rebuil		Practice of reusing sleeves on cartridge seals with pitted	
	ding		surfaces	
	Proce dures		Practice of replacing damaged (fretted) sleeves on cartridge	
			seals	
			Practice of reusing damaged (fretted) sleeves on cartridge seals	
			Practice of using OEM certified barrels in repair/rebuild	
			Practice of not using OEM certified barrels in repair/rebuild	
			Practice of replacing component seals with worn drive lugs, pins,	
			tabs, (tangs) in rotary unit	
			Practice of reusing component seals with worn drive lugs, pins, tabs, (tangs) in rotary unit	
		!	Practice of replacing component seals with missing drive lugs,	
		ļ ļ	pins, tabs, (tangs) in rotary unit Practice of reusing component seals with missing drive lugs,	
			pins, tabs, (tangs) in rotary unit	
	,	Comp		
RECEIV	FN	onent	Practice of replacing rotary units on component seals with damaged (elongated) spring holes	
			Practice of reusing rotary units on component seals with	
FEB 0 5 2	บบว		damaged (elongated) spring holes	
GROUP	360	h	Practice of replacing barrels on component seals with pitted	
			surfaces	-
			Practice of reusing barrels on component seals with pitted	
			surfaces	
			Practice of replacing damaged (fretted) rotary sleeves or barrels	
			on component seals.	
		-	Practice of reusing damaged (fretted) rotary sleeves or barrels	
	L	l	on component seals FIG. 12C	
			1.10. 120	

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_					
_		Materi	Cartrid	316SS Metallurgy	
		als of		Alloy 20 Metallurgy	
		constr		Hastelloy C Metallurgy	
		uction		Titanium Metallurgy	
				ritanium wetanurgy	
			gc w	Practice of using OEM certified face holders in repair/rebuild	
			Comp onent	Practice of not using OEM certified face holders in repair/rebuild	
				Practice of replacing face holders on cartridge seals with pitted surfaces	
	Face		Cartrid	Practice of reusing face holders on cartridge seals with pitted surfaces	
	Holder s	Repair & Rebuil	ge	Practice of replacing face holders on cartridge seals with worn drive/anti-rotation slots	
		ding Proce		Practice of reusing face holders on cartridge seals with worn drive/anti-rotation slots	
		dures		Practice of replacing face holders on component seals with pitted surfaces	
			Comp	Practice of reusing face holders on component seals with pitted surfaces	
	•		onent		
_				Practice of reusing face holders on component seals with worn drive/anti-rotation slots	
		Materi	Cartrid	316SS Metallurgy	
		als of		Alloy 20 Metallurgy	
		constr		Hastelloy C Metallurgy	• • • • • • • • • • • • • • • • • • • •
		uction	onent	Titanium Metallurgy	
			!		
			Cartrid ge &	Practice of using OEM certified lock collars in repair/rebuild	
REC		VEL	Comp onent	Practice of not using OEM certified lock collars in repair/rebuild	
FE	B 0 5	s Repair &		Practice of replacing cartridge seals with damaged/oversized set screw holes on lock collars.	
GRO	OUF		DO	Practice of reusing cartridge seals with damaged/oversized set screw holes on lock collars.	
	Lock			Practice of replacing cartridge seals with worn drive lugs, pins, tabs, (tangs) on lock collar	
	Collars		_ 1	Practice of reusing cartridge seals with worn drive lugs, pins, tabs, (tangs) on lock collar	
			ge	Practice of replacing cartridge seals with missing drive lugs, pins, tabs, (tangs) on lock collar	
				Practice of reusing cartridge seals with missing drive lugs, pins, tabs, (tangs) on lock collar	
			•	EIC 12D	

FIG. 12D

/ · ~ / / / /			
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FITTAT & TRADEMAN		Practice of replacing lock collars on cartridge seals with pitted surfaces	
		Practice of reusing lock collars on cartridge seals with pitted surfaces	
	Comp	Practice of replacing component seals with damaged/oversized set screw holes.	
	•	Practice of reusing component seals with damaged/oversized set screw holes.	
		Practice of using OEM certified faces in repair/rebuild	·
		Practice of not using OEM certified faces in repair/rebuild	
		One Piece Carbon Soft Face Material Under Compression	
		One Piece Carbon Soft Face Material Under Tension	
		Two Piece Carbon Soft Face Material Under Compression	
		Two Piece Carbon Soft Face Material Under Tension	
		Practice of replacing soft seal faces on cartridge and component seals.	
		Practice of reusing relapped soft seal faces on cartridge and component seals.	
		One Piece Ceramic Hard Face Material Under Compression	
		One Piece Ceramic Hard Face Material Under Tension	
		Two Piece Ceramic Hard Face Material Under Compression	
		Two Piece Ceramic Hard Face Material Under Tension	
		One Piece Plated TC Hard Face Material Under Compression	`
	•	One Piece Plated TC Hard Face Material Under Tension	
RECEIVE	.)	Two Piece Plated TC Hard Face Material Under Compression	
FEB 0 5 2003		Two Piece Plated TC Hard Face Material Under Tension	
GROUP 36	00	One Piece Nick. Bonded TC Hard Face Material Under Compression	
		One Piece Nick. Bonded TC Hard Face Material Under Tension	
	Cartrid ge &	Two Piece Nick. Bonded TC Hard Face Material Under Compression	
1 104-41	Comp	Two Piece Nick. Bonded TC Hard Face Material Under Tension	
Face Materi	į	One Piece Rxn Bond SC Hard Face Material Under Compression	
als of Construction		One Piece Rxn Bond SC Hard Face Material Under Tension	
	2E	Two Piece Rxn Bond SC Hard Face Material Under Compression	

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				Two Piece Rxn Bond SC Hard Face Material Under Tension	
				One Piece Alpha SC Hard Face Material Under Compression One Piece Alpha SC Hard Face Material Under Tension	
			1	Office Piece Alphia GC Hard Face Material Officer Ferision	
				Two Piece Alpha SC Hard Face Material Under Compression Two Piece Alpha SC Hard Face Material Under Tension	
		.			
		·		One Piece Chrome Oxide Hard Face Material Under Compression	
				One Piece Chrome Oxide Hard Face Material Under Tension	
				Two Piece Chrome Oxide Hard Face Material Under Compression	
				Two Piece Chrome Oxide Hard Face Material Under Tension	
				Practice of replacing hard seal faces on cartridge and component seals.	
				Practice of reusing relapped hard seal faces on cartridge and component seals.	
				Practice of replacing seal faces with corrosion/pitting on cartridge and component seals.	
				Practice of reusing seal faces with corrosion/pitting on cartridge and component seals.	
				Practice of replacing rotary units with fretting corrosion visible on ID of faces	
			Component	on rotary faces that use teflon v rings) visible on ID of faces	
				(Most common on stainless steel chrome oxide plated faces)	
	:			Practice of using OEM certified faces in repair/rebuild	
;					
				Practice of not using OEM certified faces in repair/rebuild	
				One Piece Carbon Soft Face Material Under Compression	
RF	EN			One Piece Carbon Soft Face Material Under Tension	
EE		ACT	7		
г <u>е</u> ,	P U 5	2003	i	Two Piece Carbon Soft Face Material Under Compression	
3RO	lip	260		Two Piece Carbon Soft Face Material Under Tension	
RE(FE, GRO		SOU(J	Practice of replacing soft seal faces on cartridge and component seals.	·
				Practice of reusing relapped soft seal faces on cartridge and component seals.	
	FIG		125	One Piece Ceramic Hard Face Material Under Compression	
			125	One Piece Ceramic Hard Face Material Under Tension	L

Two Piece Ceramic Hard Face Material Under Compression Two Piece Ceramic Hard Face Material Under Tension

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Cartrid Comp I/B Rotary Face Materi als of Constr uction

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One Piece Plated TC Hard Face Material Under Compression One Piece Plated TC Hard Face Material Under Tension Two Piece Plated TC Hard Face Material Under Compression Two Piece Plated TC Hard Face Material Under Tension One Piece Nick. Bonded TC Hard Face Material Under Compression One Piece Nick. Bonded TC Hard Face Material Under Tension Two Piece Nick, Bonded TC Hard Face Material Under Compression Two Piece Nick. Bonded TC Hard Face Material Under Tension onent One Piece Rxn Bond SC Hard Face Material Under Compression One Piece Rxn Bond SC Hard Face Material Under Tension Two Piece Rxn Bond SC Hard Face Material Under Compression Two Piece Rxn Bond SC Hard Face Material Under Tension One Piece Alpha SC Hard Face Material Under Compression One Piece Alpha SC Hard Face Material Under Tension Yes Two Piece Alpha SC Hard Face Material Under Compression Two Piece Alpha SC Hard Face Material Under Tension One Piece Chrome Oxide Hard Face Material Under Compression One Piece Chrome Oxide Hard Face Material Under Tension Two Piece Chrome Oxide Hard Face Material Under Compression Two Piece Chrome Oxide Hard Face Material Under Tension

Practice of replacing hard seal faces on cartridge and

Practice of reusing relapped hard seal faces on cartridge and

Practice of replacing seal faces with corrosion/pitting on cartridg

Practice of reusing seal faces with corrosion/pitting on cartridge

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FIG.

12G and component seals.

component seals.

component seals.

and component seals.

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	Two Piece Nick. Bonded TC Hard Face Material Under
	Compression
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O/B Cor	- Tura Diaga Niek Dandad IC Hard Casa Matagal Hadar Japaian I
Station one	Two Piece Nick. Bonded TC Hard Face Material Under Tension
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Face	
Materi	One Piece Rxn Bond SC Hard Face Material Under Compression
als of	
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	Two Piece Rxn Bond SC Hard Face Material Under Compression
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	Two Piece Alpha SC Hard Face Material Under Compression
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	One Piece Chrome Oxide Hard Face Material Under
	Compression
	on product
	One Piece Chrome Oxide Hard Face Material Under Tension
	Two Piece Chrome Oxide Hard Face Material Under
	Compression
	Two Bions Characa Ovids Hand Fore Metarich Hadas Tanaisa
.	Two Piece Chrome Oxide Hard Face Material Under Tension
	Practice of replacing hard seal faces on cartridge and
RECENT	, · · · · · · · · · · · · · · · · · · ·
RECEIVED	component seals.
FB 0 5 as	Practice of reusing relapped hard seal faces on cartridge and
2003	component seals.
GRALL	
THUH REAL	Practice of replacing seal faces with corrosion/pitting on cartridge
I I OOUD	and component seals.
GROUP 3600	Practice of reusing seal faces with corrosion/pitting on cartridge
	and component seals.
	Practice of replacing rotary units with fretting corrosion visible on
	ID of faces
Coi	np Dracking of reveing retary units with from a consider (conserve)
one	Practice of reusing rotary units with fretting corrosion (common
	on rotary faces that use teflon v rings) visible on ID of faces
	(Most common on stainless steel chrome oxide plated faces)
	Practice of using OEM certified faces in repair/rebuild
	Tractice of using OEW certified faces in repair/rebuild
	Practice of not using OEM certified faces in repair/rebuild
	Tradice of not doing of the certified races in repair/rebuild
	One Piece Carbon Soft Face Material Under Compression
	One Piece Carbon Soft Face Material Under Compression One Piece Carbon Soft Face Material Under Tension

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	Two Piece Carbon Soft Face Material Under Compression	
	Two Piece Carbon Soft Face Material Under Tension	
	Practice of replacing soft seal faces on cartridge and component seals.	
	Practice of reusing relapped soft seal faces on cartridge and component seals.	
	One Piece Ceramic Hard Face Material Under Compression	
	One Piece Ceramic Hard Face Material Under Tension	
	Two Biose Coromic Hard Face Material Under Compression	
	Two Piece Ceramic Hard Face Material Under Compression Two Piece Ceramic Hard Face Material Under Tension	
	One Piece Plated TC Hard Face Material Under Compression One Piece Plated TC Hard Face Material Under Tension	
	One Fiece Flated TC Hard Face Material Orider Terision	
	Two Piece Plated TC Hard Face Material Under Compression	
	Two Piece Plated TC Hard Face Material Under Tension	
	One Piece Nick. Bonded TC Hard Face Material Under Compression	
	One Piece Nick. Bonded TC Hard Face Material Under Tension	
Cartrid ge &	Two Piece Nick. Bonded TC Hard Face Material Under Compression	
Comp	Tura Diago Miak, Dandad TC Uard Easa Matarial Under Tanaian, 1	
	One Piece Rxn Bond SC Hard Face Material Under Compression	
	One Piece Rxn Bond SC Hard Face Material Under Tension	
	Two Piece Rxn Bond SC Hard Face Material Under Compression	
	Two Piece Rxn Bond SC Hard Face Material Under Tension	
	One Piece Alpha SC Hard Face Material Under Compression	
	One Piece Alpha SC Hard Face Material Under Tension	
	Two Piece Alpha SC Hard Face Material Under Compression Two Piece Alpha SC Hard Face Material Under Tension	-,
)	One Piece Chrome Oxide Hard Face Material Under Compression	
	One Piece Chrome Oxide Hard Face Material Under Tension	
2J	Two Piece Chrome Oxide Hard Face Material Under Compression	

O/B Rotary Face Materi als of Construction

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FIG. 12J

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,				
	:		Two Piece Chrome Oxide Hard Face Material Under Tension	
			Practice of replacing hard seal faces on cartridge and component seals.	
			Practice of reusing relapped hard seal faces on cartridge and component seals.	
			Practice of replacing seal faces with corrosion/pitting on cartridge and component seals.	
			Practice of reusing seal faces with corrosion/pitting on cartridge and component seals.	
·			Practice of replacing rotary units with fretting corrosion visible on ID of faces	
:		Comp onent	Practice of reusing rotary units with fretting corrosion (common on rotary faces that use teflon v rings) visible on ID of faces (Most common on stainless steel chrome oxide plated faces)	
			Soft Face Combination Carbon/Carbon	
			Soft Face Combination Carbon/Ceramic	
			Soft Face Combination Carbon/Plated TC	
	О/В	ge & Comp	Soft Face Combination Carbon/Nick. Bonded TC	
	Faces In Combi		Soft Face Combination Carbon/Rxn Bond SC	
			Soft Face Combination Carbon/Alpha SC Soft Face Combination Carbon/Chrome Oxide	
	nation	onent		
			Hard Face Combination SC/SC	
			Hard Face Combination SC/TC Hard Face Combination TC/TC	
			Hard Face Combination 76/76 Hard Face Combination Cer/Cer	
		Cartrid	O-ring Elastomer Type	
	I/B		Teflon V-Ring Elastomer Type	Yes
	Design	Comp	Teflon Wedge-Ring Elastomer Type	
		onent	Teflon U-Cup Elastomer Type	
			Viton Elastomer Material	
	I/B	Cartrid	EPR Elastomer Material	<u></u>
	Materi	ge &	Teflon Elastomer Material	
	als of Construction	0	Aflas Elastomer Material	
			Kalrez Elastomer Material Chemraz Elastomer Material	
	uotion		Graphoil Elastomer Material	9
		Cartrid	O-ring Elastomer Type	
	O/B	ge &	Teflon V-Ring Elastomer Type	77
Elasto	Design	•	Teflon Wedge-Ring Elastomer Type	
mers		onent	Teflon U-Cup Elastomer Type	6
			Viton Elastomer Material	
.	O/B	Cartrid	Teflon Elastomer Material FIG. 12K	<u> </u>
	Materi als of	ge &	Aflas Elastomer Material	
	Oi	Comp	/ mas Liastomer iviaterial	<u>L</u>

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ADEMARK OF	Constr	onent	Kalrez Elastomer Material	
	uction	O'ICII	Chemraz Elastomer Material	
			Graphoil Elastomer Material	
		·		
	Repair &	Cartrid	Practice of using OEM certified elastomers in repair/rebuild	
-	Rebuil ding	ge & Comp	Practice of not using OEM certified elastomers in repair/rebuild	
	Proce	onent	Practice of replacing elastomers	
	dures		Practice of reusing elastomers	
			Spring Type (Wave Spring)	
		Cartrid	Spring Type (Single Coil)	
	Design	ge &	Spring Type (Multiple Coil)	Yes
	Design	Comp	Metal Bellows Design	
		onent	Out of Fluid Design	
·			Immersed in process fluid Design	Yes
				163
	Materi		316SS Metallurgy	
	als of		Alloy 20 Metallurgy	
Face Energi	constr	Comp	Hastelloy C Metallurgy	
	uction	onent	Titanium Metallurgy	
zing			Practice of using OEM certified springs in repair/rebuild	
Mecha				
nism			Practice of not using OEM certified springs in repair/rebuild	
		Cartrid		
	Repair		Practice of using OEM certified metal bellows in repair/rebuild	
	&	Cartrid	Tradition of doing o'Elit detailed metal bellows in repail/rebuild	
	Rebuil ding	ge & Comp	Practice of not using OEM certified metal bellows in repair/rebuild	
· ·	Proce	onent		
	dures		Practice of replacing springs	
			Practice of reusing springs '	
			Practice of replacing metal bellows	
			Practice of reusing metal bellows	
	Popoi-		Practice of using OEM certified gaskets in repair/rebuild	
Gaske	Repair	Comp		<u> </u>
	& Rebuil ding Proce dures		Practice of not using OEM certified gaskets in repair/rebuild	
ts				
			Practice of replacing gaskets	
			Practice of reusing gaskets	
			Stuffing Box Face Perpendicularity	.003"
			- 2	
Seal				
Setting				
s				
			T % % , O	
			A V	L

FIG. 12L

	J 1302	!	_			_	<u>7</u>	•					<u> </u>
Process Fluid	Acetone; Tem <210 F	System Recommendations	150 F	Yes	Yes	No	1.1	45 PSIA	15000 SSU	75%	1%	0.50%	2%
			Product Temperature	Product Crystalizes	Product Polymerizes	Product is Thermal Sensitive	Specific Gravity	Vapor Pressure	Viscosity	Concentration	% Dissolved Solids	% Undissolved Non-Fibrous Solids	% Undissolved Fibrous Solids

CROUP STORY

09/695,716

1400~	MTBF (Mean Time Between Failure) for seals in years	
402~	# of days/year plant operates	
104~	# of hours/day plant operates	
406~	Kilowatts/hours for Avg. balanced seal	
	Additional power required for unbalanced seal	
108~	Average # of repacks per year	· · · · · · · · · · · · · · · · · · ·
	Average # of adjustments per year per box	
	Average Life of Shaft/Sleeve (in years) Before	
	Replacement Is Required Due To Packing & Bearing	· ·
	Failure Damage	
	Avg. Seal Water (in gpm) Flush Entering Each Packed	•
	Stuffing Box , Entering the process stream	
	Average Seal Water Flush (in gpm) required for a	
	single mechanical seal entering the process stream.	
	The Reduction in Seal Water Usage Per Stuffing Box	
	By The Use Of Mechanical Seals	
	Change In Temp. Difference Between System Temp.	
	and Seal Water Flush Temp. (Ex. 85 Deg.F. system	
	temp., 65Deg.F. Seal Water Temp = 20 Deg.F.)	
	Avg. Requirement For A Packed Pump is 2KW Per	
	Hour. Avg. For A Balanced Mechanical Seal Is .33KW	
	Per Hour (The Excess Power Required Per Pump Is	
	1.67 KW/Hour) Based on 2.000 " seal, adjust up or	
	down by average shaft/ sleeve size in plant	
	Avg. Leakage of Each Stuffing Box in Drops/Min	
	# of Machines With Unscheduled Downtime	
	0.45	
	% of Equip. Requiring Unscheduled Repairs As a	
	Result of Excess Leakage (Ex. Bearing failure due to	
	product leakage contamination)	
	Frequency of shaft /sleeve replacement	
	% of Component Seals In Which Installation Is Not	
	Correct The First Time	
	Increased MTBF provided by superior seal design.	A
	Average Decrease In Seal Life For The Entire Plant	45
	Seal Population Due To Existing Design Deficiencies	
		100 S TO
	FIG. 14A	CROUND SOUTH
•		6

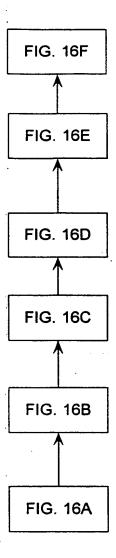
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1	LATES and the COD and	
1	Increased MTBF provided by ESP software	·
Plant	technologies assuring that the correct seals with	
Informa	correct materials of construction and environmental	
tion	controls with engineering documentation provides	
	unsurpassed plant efficiencies.	
	Increased MTBF provided plant reliability software	
	which enables identification of problems preventing	
	reinstallation of those problems.	
	Overall Decrease in Seal Life Due To Premature	
	Failure. (Over compressed & Under compressed	
	component and erroneous installations)	·
	Additional Hours Req'd For Installation vs. Cartridge	
	Design	
	Additional Hours Req'd For Component vs. Cartridge	
	Design	
	Average Installation Time For A Component Seal	
Labor	Hours Required For Disassembly & Reinstallation of	
Informa	Seal	
	Average # of Manhours Per Repack	
tion	Average # of Manhours Per Adjustment	
	Average # of Manhours Per Replacement	
	# of Hours Machinery Is Down Per Year Due to Eqpt	
1	Failure Attributed to Product Leakage	
	# of Housekeeping / Hours Per Year Per Pump	
	(Cleaning Leakage)	
1	# of Hours To Install One Mechanical Seal	

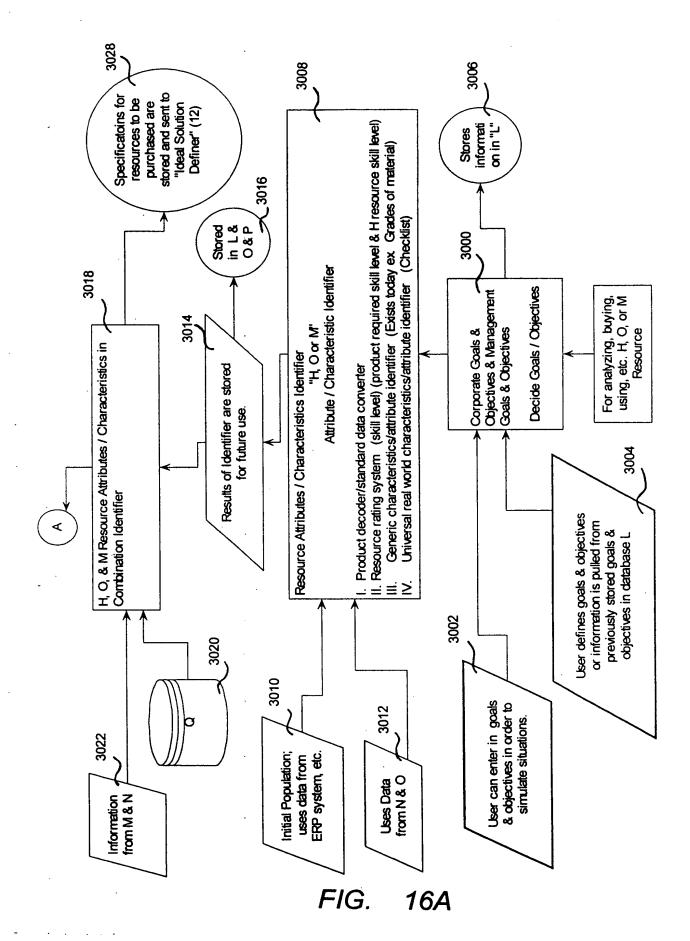




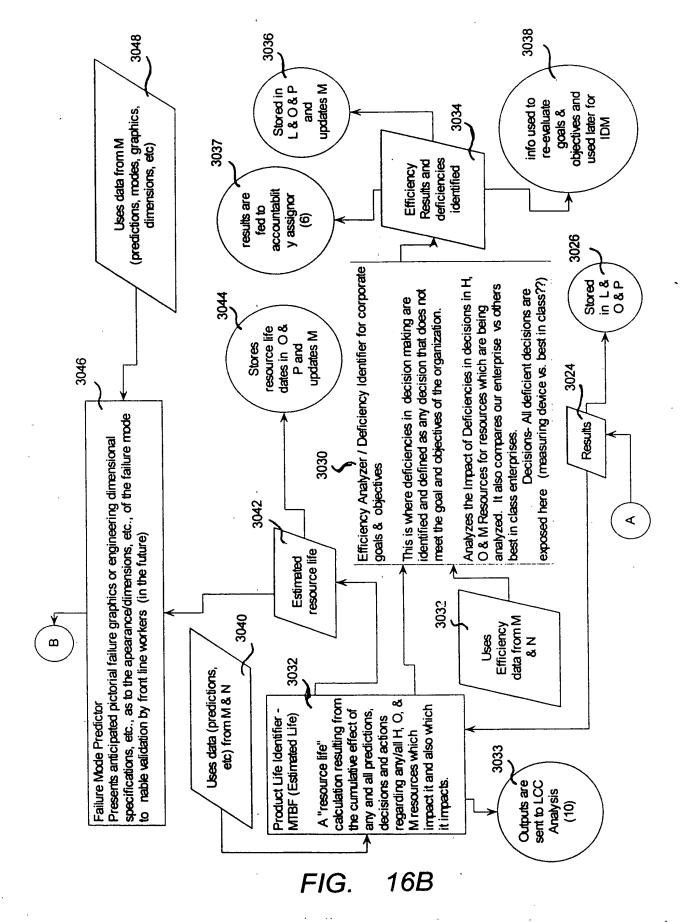


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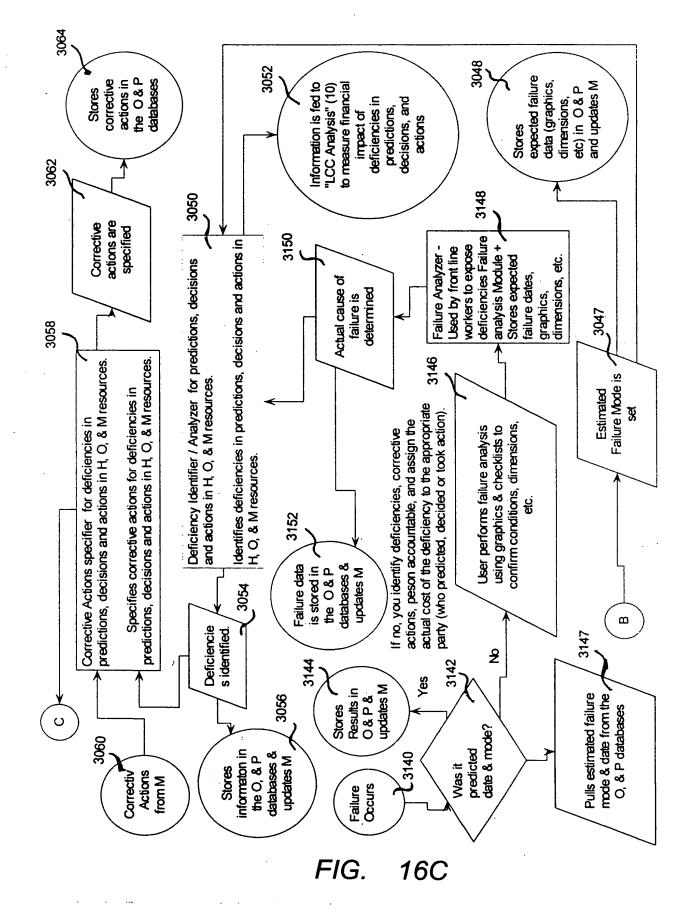
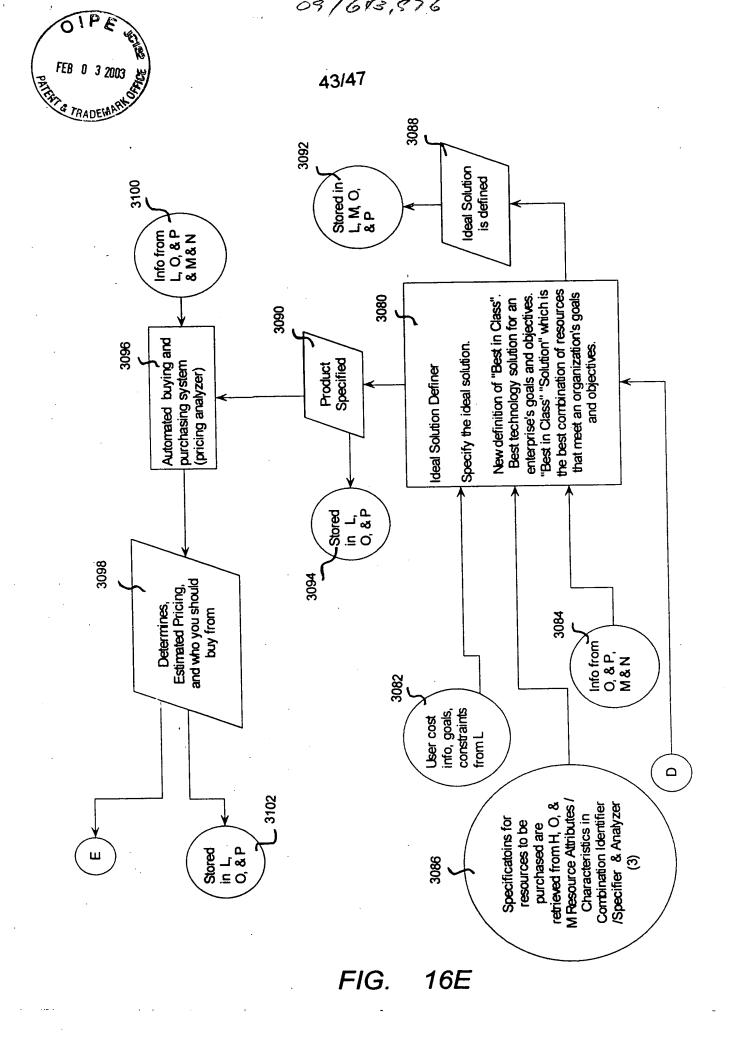
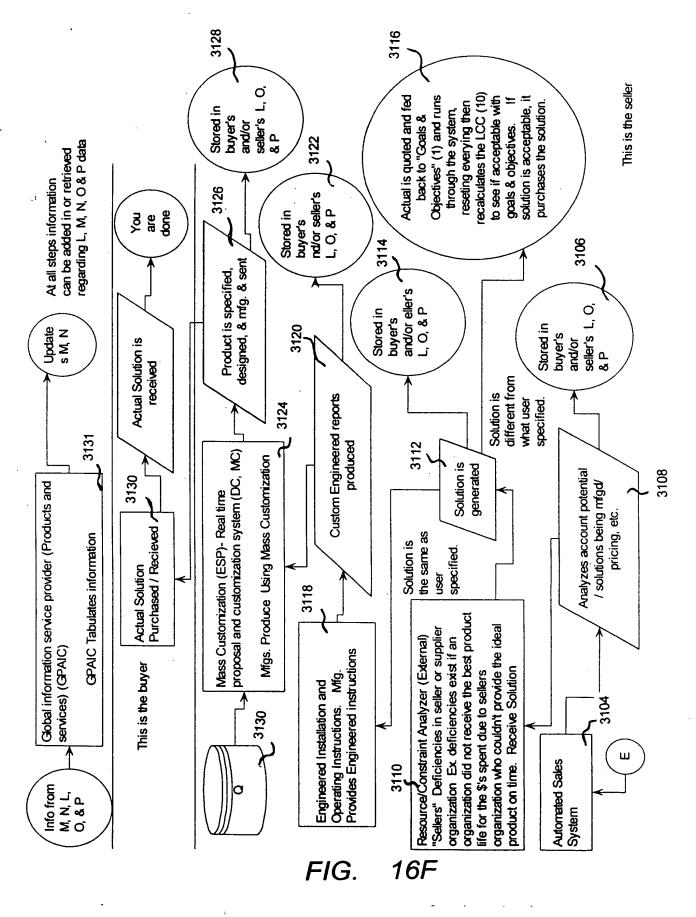


FIG. 16D





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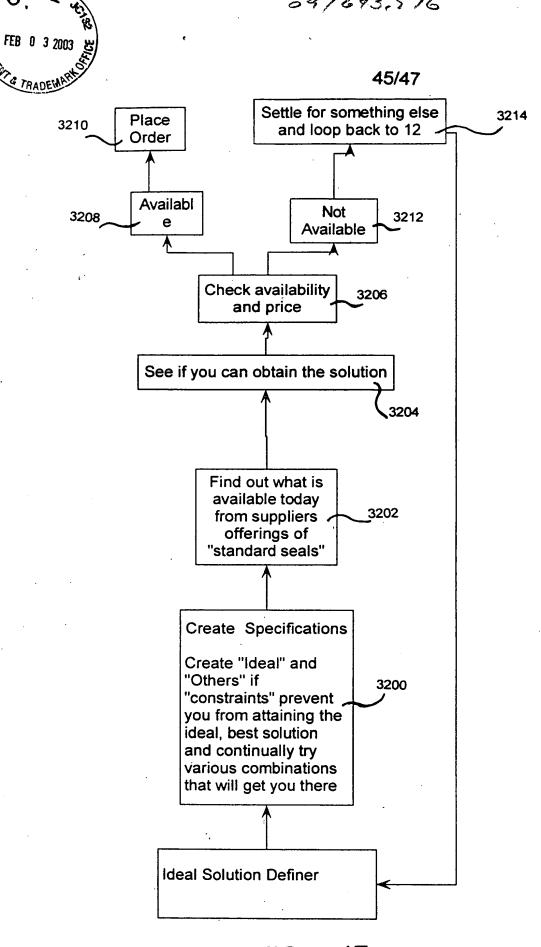


FIG. 17



L			1800			,						7	+0.Y0.C	Gird
	Each test is performed under		Mfg. of Component		-	Ŗ	Face Suppliers	ers	O ir	O-ring Suppliers	ø	Supplier s	Gasker Supplie rs	Supplier s
	<u> </u>	Raw Materia I Mfqs	Material		ì	Material PG523	Material PG792	Material PG957	Grade A	Grade B	Grade C	. Etc.	Etc.	Etc.
		Perfor m Laborat ory				Estimate	Estimate	Estimated Estimated	Estimated	Estimated	Estimat			
	of each in a controlled	Tests	Estimated Life			d life 5 years	d life 15 years	life 35 years	life 1 year	life 5 years	ed lile 10 years	12 years	& years	12 years & years 20 years
	environment on test stands									~,				
			1802			1808	1			210				
L			Mfg. of]	Bearing	-		Seel Meas			Shaft	Impeller	Himon
40	Each test is		Subassemb ly	Веапп	Bearing Mfgs	Protectio n Mfgs			Seal Migs			Mfgs	Mfgs	
	under											Shaft		Scientist
	laboratory conditions with			Option 1		Double lip seal						with L3/D4 of		s/ experts
	pre-selected expert	nent Mfgs	Design	CB Design	Option 2	design made of Viton	Balance	d design 75 multi	Balanced design 75/20 with face width of 100 with multi coil springs, etc.	se width of 1 , etc.	100 with	3 made of 316SS	Open	assembl e in clean
	Estimated life	Perfor m		lube	Design	with x duromet	·-		.			with bearing	design	room
· 	controlled environment Ex. Water	Laborat ory Tests		system		er,		-				toleranc e of .005		ment, etc. etc.
	and 6% oil solution, 70			Estimat	Estimat	Estimate		U	ofil botomito	d		Estimate	Estimat	
	fee room, etc., etc.,		Estimated Life	ed life 30 years	7			· 	5 years	υ	_	d life 50 years	ed/life 6 years	
						<u> </u>		$\frac{1}{1}$	1812 –		+	1	$\frac{1}{2}$	1
İ					/	— 月		_			*	•	~	-

FIG. 18A

		- T		T	•	П						
		Controlled laboratory conditions of 70 degrees, same trained stalls all components, etc.	Seal mfg Life from above	5 years	1814 Estimated life could have been 12 years but now it is 3 years due to less than best in class offerings					Estimated life could have been 3 years but now it is 195 days due to less than best in class offerings		
•		ratory conditi nents, etc.	Design with axial shaft play .006010	5 years	ears due to le		ıl World)			days due to l		
	Pump Mfgs	testing. Controlled laboratory con expert installs all components, etc.	Design with axial shaft play < .006	10 years	now it is 3 y		End User Plants (Real World)			now it is 195		
	-	testing. Co	Rigidity of Design Shaft with axi based on shaft pl overhang < .006		2 years but		End Use			years but i		
		Very limited controlled environment testing.	Frame Adapter Fits .005-	5 years	ive been 1		:	Equipme nt Conditio n Shaft Run out .005-	700 days	ive been 3		
•		itrolled en	Frame Adapter Fits <	15 years 5 years	e could ha			Equipme nt Conditio n Shaft Run out < .004	1000 days	e could ha		
		imited cor	Bearing Housing Fits .010	3 years	1814 timated life		•	i Installati on of pump with H skill level of	1095 days	timated lif		
		Very	Bearing Housing Fits .0025	10 years	S3			Installati on of Pump with H skill level of	195 days	Es		
کر چ	· :	Mfg. of Assembly	Design	Estimated Life for each item	Assembly Estimated Life		User of Assembly	Design	Estimated Life for each item	Assembly Estimated Life		
1804 1		Equipm ent Mfgs Perfor m Laborat ony Tests						Users perform Real World testing				
			Tests all pieces in	combination in controlled environment				Invention combines scientists findings with field findings of "H", "O", &	in combination and enables predicted	outcomes		
	<u></u>)					10					
					FIG		18	K				

FIG.

18B